REMARKS

The Applicant respectfully requests that the Examiner reconsider the rejection of the claims in this application in the light of the foregoing amendments and the following remarks.

No new matter is added by any of the amendments to the claims. Written support for the amendments to Claims 1 and 6 is found at page 4, lines 1 to 12 of the Specification.

Objection to the Specification

The Examiner objected to the Specification because on page 6, at line 10, the term "pressure" is expressed in tons, a unit of force or weight. Correction was required. The text at page 6, line 10 has been amended to recite an appropriate unit of pressure, tons per square inch (tsi). Accordingly, it is believed that the objection is overcome.

35 USC 112, Second Paragraph: Claims 4 and 9

The Examiner rejected Claims 4 and 9 under 35 USC 112, second paragraph, as being indefinite. The Examiner explained that in both Claims 4 and 9 the "pressure" was expressed in tons, a unit of weight measure.

Claims 4 and 9 have been amended to replace the term "tons" with "tsi", a unit of pressure. Accordingly, it is believed that Claims 4 and 9 meet the requirements of the statute.

35 USC 103(a): Claims 1-3 and 5

The Examiner rejected Claims 1-3 and 5 under 35 USC 103(a) as being unpatentable over

US 4,389,362 (Larsson) in view of US 4,723,999 (Hasselström).[1] In explaining the rejection, the Examiner reasoned that the process described in Larsson differs from the Applicants' claimed process because Larsson (1) does not disclose that the metal powder is prepared by gas atomization; (2) that the material making up the second capsule is metal; and (3) that the metal second vessel is compacted under sufficient pressure to partially consolidate the metal powder so as to retain a desired amount of porosity. The Examiner went on to explain that Hasselström describes a powder metallurgy process that includes features (1) and (2) missing from Larsson. With respect to feature (3) of the Applicants' claimed process the Examiner stated:

> As for (3) above, the process of Larsson appears to produce product with fully or substantially full the [sic] theoretical density, which reads on the claimed 'a desired porosity', which includes zero porosity, i.e., 100% dense. Nonetheless, it is commonly known in the art that the density or porosity of a product can be controlled by the size and shape of the powder, compacting pressure, compacting temperature and/or time. Therefore it would have been obvious to one of ordinary skill in the art to vary the process conditions of Larsson to obtain the desired density of porosity.

This rejection is traversed in view of the amendment of Claim 1 for the following reasons.

Although Hasselström relates to a method of manufacturing an object using powder metallurgy, the process described in Hasselström is different in several respects from the Applicants' claimed process as set forth in Claim 1. For example, Hasselström describes a process that uses an open-ended ceramic mold to hold the powder. The top of the ceramic mold is covered with an oxide or lime prior to the consolidation step. The objective of that step is to

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[1] Although the first line of Paragraph 5 of the Action states that Claims 1-3 and 5 are rejected under 35 USC 102(b), the rejection is clearly based on Section 103(a) because it relies on a combination of references. Therefore, the rejection is being treated as based on Section 103(a).

prevent the pressurizing liquid medium from entering the powder during the high temperature consolidation cycle. The Applicants' claimed process uses a degassed and sealed metal can.

Hasselström discloses consolidation of the powder at high pressures using temperatures between 1200 and 1450°C and using an autoclave. That process uses liquid phase sintering in combination with pressure to reduce consolidation times. The Applicants' claimed process uses a temperature below 1100°C, which achieves structural uniformity through solid state diffusion in combination with the controlled pressure needed to produce the porous structures that characterize the product of the Applicants' claimed process.

The processes described in Larsson and Hasselström are designed to produce a fully densified structure. The Applicants' claimed process is much less complex, uses a simple hydraulic press to consolidate the powder and produces a segregation free controlled porosity structure. Neither Larsson nor Hasselström discloses or suggests such a result, nor do either of those references provide any motivation for a person skilled in the art to make a metal mold or die tool that has such a property. Moreover, the neither Larsson nor Hasselström recognizes the problem to which the Applicants' claimed process is directed.

The known tools for plastic injection molding machines are made from cast and wrought steel and have been available for over 50 years. The known machines are designed so that air can vent from the mold cavity as it is filled with the plastic material. The tools are usually inefficiently cooled by water passing through channels drilled into the mold walls. Production efficiency is low because the plastic component must remain in the mold until it is solid enough to hold its shape and be ejected. Other features such as surface quality can also be impaired by

such cooling inefficiencies. Better and more consistent cooling of the mold would mean that the solidification temperature of the plastic material could be reached sooner, thus reducing cycle time, and increasing productivity.

Based on current knowledge of gas and gas usage, polymer processing techniques, and the metallurgy of tool materials, a new cooling technology has been developed which has been described as a major breakthrough for the plastic forming industry and especially for plastic injection molding. This technology holds promise for increased productivity, greater design freedom for complex products, increased profits and a widened product scope because it has the potential to reduce production cycle times by 20 to 40%.

The new technology is an advanced cooling concept in which liquid cooling gas is injected into the mold where it evaporates. The resulting gas vents from the mold. This technology requires a mold material manufactured with uniform and controlled porosity to effect optimum cooling. By including micropores throughout the mold material, the evaporative cooling points can be situated close to the forming surface of the mold. There is no restriction on the geometry of the mold as there is with molds made with drilled water channels.

While the technology of gas cooling is viable, the difficulty has been the availability of a suitable material for the molds and the inability to obtain a controlled and consistent quality level of microporosity in the mold material. Further, prior to the Applicant's claimed process, no efficient technique was available to manufacture a composite mold with a porous body and a solid surface layer, as is required in many applications where surface quality is of paramount importance.

Attempts to manufacture such tooling by conventional powder metallurgy press-and-sinter techniques, such as that described in Hasselström, have failed to produce the desired results. Those techniques cannot produce the required porosity levels with the degree of control required. The press-and-sinter technique produces a non-uniform pore size in the tool material. With that type of variation in pore size, the cooling of the tool surface cannot be controlled, and the advantages of the new gas cooling technology cannot be effectively utilized. Further, conventional powder metallurgy press-and-sinter technology cannot produce a solid surface on the tool, while at the same time producing a controlled and consistent microporous substructure.

The Applicants' claimed process as set forth in Claim 1, includes the step of compacting the metal vessel under sufficient pressure to partially consolidate the metal powder so as to retain porosity therein in an amount sufficient to permit air to vent through the metal tool. The claimed process permits the manufacturing of microporous, corrosion resistant molds and die tools that not only increase the productivity of plastic injection molding machines, but that also eliminate cooling and quality difficulties that have been encountered with the conventionally fabricated molds. Because the injection molds and die tools made by the Applicants' claimed process are uniformly porous, air can vent through the walls of the mold or die as the plastic material is injected into the mold cavity. This eliminates the venting problem of the known molds and dies.

In addition, with the metal molds and die tools made from the Applicants' claimed process a small amount of cooling liquid gas can be injected into the mold to permit release of the part quickly and easily after injection of the plastic into the mold cavity. This results in fewer jammed injection machines and fewer parts being rejected because of ejector marks. Overall, the Applicants' claimed process provides tooling for plastic injection molding that has significant

cooling, air venting, and surface quality advantages compared to the tooling currently used in the industry.

For all of the foregoing reasons, it is believed that the Applicants' claimed process as set forth in Claim 1 is patentable over the combination of processes described in the cited references.

Claims 2-5 depend from Claim 1 either directly or indirectly, and therefore are allowable for at least the same reasons as Claim 1.

35 USC 103(a): Claims 6-8 and 10

The Examiner rejected Claims 6-8 and 10 under 35 USC 103(a) as being unpatentable over Larsson in view of Hasselström and US 4,063,940 (Dain et al.). In explaining this ground of rejection the Examiner stated: "Larsson in view of Hasselström discloses the method for making billets of complicated shape as stated in paragraph 5 above. The difference between Larsson in view of Hasselström and claim 6 is that there is no teaching of making composite metal, wherein a piece of a fully consolidated metal is placed in a metal container before filling the metal container with metal powder." The Examiner then goes on to explain that Dain et al. describes a powder metallurgy method wherein a composite article is made from metal powder that is bonded to a metallic insert. The Examiner concluded that it would have been obvious to combine the process described in Dain et al. with the processes described in Larsson and Hasselström. The Applicants traverse this ground of rejection for the following reasons.

It should now be clear that the combination of Larsson and Hasselström does not anticipate the Applicants' claimed process as set forth in Claim 1. Claim 6 includes all of the

steps set forth in Claim 1 and the additional steps of placing a piece of a fully consolidated metal in the metal container and compacting the metal powder in the metal container under sufficient pressure to bond the metal powder to the fully consolidated metal piece and to partially consolidate the metal powder so as to retain porosity therein in an amount sufficient to permit air to vent through the metal tool. The Examiner concedes that neither Larsson nor Hasselström describe or suggest that combination.

Dain et al. does not fill the void in the proposed combination of Larsson and Hasselström. In the process described in Dain et al., the powder is cold compacted using a lubricant and then is sintered to as high a density as possible. That process cannot control the porosity of the consolidate material. The Dain et al. process requires intermediate treatments to soften the powder for cold compaction and to reduce the oxygen level in the material. The Dain et al. process also uses a lubricant to enable the formation of a cold compact prior to sintering. The use of the lubricant introduces a contaminant into the material. The non-pressurized sintering required in the Dain et al. process is performed above the solidus temperature of the material and results in some liquation and segregation in the material. The Applicants' claimed process is performed at an elevated temperature below the solidus temperature so as to control and produce a homogeneously porous structure.

Nor does Dain et al. provide any suggestion or motivation to make a metal mold or die tool having controlled porosity. The process described in Dain et al. is designed to compact the metal powder to full or substantially full density. Any porosity remaining in a mold or die tool made by the Dain et al. process would be randomly distributed and would not permit sufficient air to vent, if any.

For all of the foregoing reasons, it is believed that the Applicant's claimed process as set forth in Claim 6 is patentable over the combination of processes described in the cited references.

Claims 7-10 depend from Claim 6 either directly or indirectly, and therefore are allowable for at least the same reasons as Claim 6.

CONCLUSION

In view of the foregoing amendments and remarks, it is believed that the claims of this application are in condition for allowance. The Examiner is respectfully requested to reconsider the application in the light of the amendments and remarks presented hereinabove.

Respectfully submitted,
DANN, DORFMAN, HERRELL AND SKILLMAN
A Professional Corporation
Attorneys for Applicant

By Vincent T. Pace
Vincent T. Pace
PTO Registration No. 31,049

Tel: 215-563-4100
Fax: 215-563-4044
Email: vpace@ddhs.com